

FAR/JAR 25.671 FCHWG - ARAC Report

(Includes Rule, Advisory Material, & Alternate Recommendations)

- 1. What is the underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why should the requirement exist? What prompted this rulemaking activity (e.g., new technology, service history, etc.)?]**

This requirement ensures the basic integrity and availability of flight control systems, and further ensures that any failure experienced in service is manageable by the aircrew and will not prevent continued safe flight and landing. This rulemaking activity was prompted by efforts to harmonize the FARs and JARs, recommendations from the NTSB as a result of accident investigation, and the need to update the rule to address recent Special Conditions applied to fly-by-wire control systems.

- 2. What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]**

Current FAR Text:

FAR 25.671 General.

- (a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.**
- (b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimize the probability of incorrect assembly that could result in the malfunctioning of the system.**
- (c) The airplane must be shown by analysis, tests, or both, to be capable of continued safe flight and landing after any of the following failures or jamming in the flight control system and surfaces (including trim, lift, drag, and feel systems), within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable malfunctions must have only minor effects on control system operation and must be capable of being readily counteracted by the pilot.**
 - (1) Any single failure, excluding jamming (for example, disconnection or failure of mechanical elements, or structural failure of hydraulic components, such as actuators, control spool housing, and valves).**
 - (2) Any combination of failures not shown to be extremely improbable, excluding jamming (for example, dual electrical or hydraulic system failures, or any single failure in combination with any probable hydraulic or electrical failure).**
 - (3) Any jam in a control position normally encountered during takeoff, climb, cruise, normal turns, descent, and landing unless the jam is shown to be extremely improbable, or can be alleviated. A runaway of a flight control to an adverse position and jam must be accounted for if such runaway and subsequent jamming is not extremely improbable.**

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- (d) The airplane must be designed so that it is controllable if all engines fail. Compliance with this requirement may be shown by analysis where that method has been shown to be reliable.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-23, 35 FR 5674, Apr. 8, 1970]

Current JAR Text:

JAR 25.671 General

- (a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function (See ACJ 25.671 (a).)
- (b) Each element of each flight control system must be designed or distinctively and permanently marked, to minimise the probability of incorrect assembly that could result in the malfunctioning of the system. (See ACJ 25.671 (b).)
- (c) The aeroplane must be shown by analysis, test, or both, to be capable of continued safe flight and landing after any of the following failures or jamming in the flight control system and surfaces (including trim, lift, drag, and feel systems) within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable malfunctions must have only minor effects on control system operation and must be capable of being readily counteracted by the pilot.
 - (1) Any single failure not shown to be extremely improbable, excluding jamming, (for example, disconnection or failure of mechanical elements, or structural failure of hydraulic components, such as actuators, control spool housing, and valves). (See ACJ 25.671(c)(1).)
 - (2) Any combination of failures not shown to be extremely improbable, excluding jamming (for example, dual electrical or hydraulic system failures, or any single failure in combination with any probable hydraulic or electrical failure).
 - (3) Any jam in a control position normally encountered during take-off, climb, cruise, normal turns, descent and landing unless the jam is shown to be extremely improbable, or can be alleviated. A runaway of a flight control to an adverse position and jam must be accounted for if such runaway and subsequent jamming is not extremely improbable.
- (d) The aeroplane must be designed so that it is controllable if all engines fail. Compliance with this requirement may be shown by analysis where that method has been shown to be reliable.

- 3. **What are the differences in the standards? [Explain the differences in the standards or policy, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]**

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The JAR allows for the demonstration of single failures to be shown extremely improbable and also includes ACJ advisory material for paragraphs (a), (b), and (c)(1). Due to their similarity, there has been little effect on cost or safety to comply with one standard or the other.

4. **What, if any, are the differences in required means of compliance? [Provide a brief explanation of any differences in the current compliance criteria or methodology (e.g., issue papers), including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]**

In practical terms, there has been little difference in the means of compliance between JAR and FAR. The FAA in specific instances has also allowed certain single failures to be shown to be extremely improbable.

Another area of difference is that in compliance demonstration, the FAA has allowed use of the Handling Qualities Rating Method of AC 25-7, which is not recognized by the JAA.

Also an issue has been the term "extremely improbable" as used in FAR/JAR 25.671(c)(2). Both the FAR and JAR paragraphs identify examples of "any combination of failures not shown to be extremely improbable." One of these examples is any single failure in combination with any probable failure. The FAA has considered this example to be a requirement, while the JAA has considered it to be just an example which is not specifically required.

In regard to 25.671, the greatest issue is a need for basic rule clarification and advisory material to produce more consistent demonstration of compliance for jam failure conditions from one airplane program to the next. This is reflected in recent FAA Issue Papers (which were not harmonized) and policy letters regarding Jam Failure Conditions, such as Issue Paper F-2 (applied to 737NG).

5. **What is the proposed action? [Describe the new proposed requirement, or the proposed change to the existing requirement, as applicable. Is the proposed action to introduce a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen for each proposed action.]**

Harmonized revisions are proposed to the rule accompanied by advisory material to achieve greater consistency in demonstration of compliance for flight control jam failures. This includes definition of "normally encountered position" and "continued safe flight and landing". A summary of changes is listed below.

- 25.671(a) Includes material from recent fly by wire certifications requiring operation in any attitude.

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- 25.671(b) Revised to discourage marking alone as a desired means of ensuring correct assembly.
- 25.671(c) Negligible change.
- 25.671(c)(1) Clarifies which jamming to be excluded from "any single failure". Removes "extremely improbable" as a means of compliance.
- 25.671(c)(2) Added 1/1000 specific risk to numerical analysis. Clarifies which jamming to be excluded.
- 25.671(c)(3) Provides (c)(3) jam definition. Removes "extremely improbable" as a means of compliance. Adds 1/1000 specific risk analysis on additional failure conditions. Adds recognition of the difficulty in covering the time period just before landing.
- 25.671(c)(4) Highlights requirement to address runaway. Requires addressing single failure regardless of probability.
- 25.671(d) Clarifies all engine-out flight to be considered at any point in the flight. Requires flare capability.
- New-25.671(e) Adds requirement for recognition of control means at the limits of authority from recent fly by wire certifications.
- New-25.671(f) Adds requirement for mode annunciation from recent fly by wire certifications.

AC/AMJ Material:

- Includes Current ACJs
- Provides Advisory Material for All Paragraphs of 25.671
- Defines "Normally Encountered Positions"
- Defines Criteria for "Continued Safe Flight & Landing"
- Provides Examples of Compliance for 1/1000 Specific Risk Criteria

6. What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

See the rule changes and advisory material in Enclosures 1 and 2.

7. How does this proposed standard address the underlying safety issue identified in #1? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

This standard requires the use of "Fail Safe" compliance methods and analysis techniques common to 25.1309 to ensure safety following single failures and combination of failures not extremely improbable. This includes consideration of the effect of dormant failures and specific demonstration of acceptable operation following flight control failure conditions. A 1/1000 probability requirement is used to ensure a minimum residual level of safety following a single failure or jam and

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replace the "single plus probable" material included in the parentheses of the current 25.671(c)(2). Definitions of "normally encountered position" and "continued safe flight and landing" are included in the advisory material. Use of advisory material is appropriate for these definitions since some variation can be expected due to the characteristics of individual flight control systems.

- 8. Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]**

The proposed standard will increase the level of safety through expansion of the flight envelope in which jams are demonstrated and through specific criteria which defines "continued safe flight and landing". Safety is also increased by requiring a specific residual level of safety following a single failure. Comments on the effect of each change on safety are included below.

- 25.671(a)** Includes material from recent fly by wire certifications requiring operation in any attitude. This change will increase the level of safety by providing coverage absent in the current FAR/JAR.
- 25.671(b)** Revised to discourage marking alone as a desired means of ensuring correct assembly. This change will increase safety by promoting greater use of design features that ensure correct assembly.
- 25.671(c)** Negligible change.
- 25.671(c)(1)** Clarifies which jamming to be excluded from "any single failure". Removes "extremely improbable" as a means of compliance. This change will increase safety since all single failures must now be considered.
- 25.671(c)(2)** Added 1/1000 specific risk to numerical analysis. Clarifies which jamming to be excluded. The FCHWG proposal removes the single plus probable failure combination from 25.671(c)(2) which is somewhat ambiguous and has been inconsistently applied, and replaces it with the 1/1000 specific risk criteria. The proposed criteria is both more conservative and less conservative than the current standard. In addition to a single failure, the current standard requires the inclusion of any probable failure, using a 10^{-5} failure rate as the determining factor. The new standard would require, in addition to any single failure, the inclusion of any failures which have combined probability of greater than 1/1000. The new standard thus prescribes a more moderate residual failure probability, but it applies to all possible failure conditions, including dormant failures. The new standard also has the advantage of being more clear than the existing requirement.

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- 25.671(c)(3) Provides (c)(3) jam definition. Removes "extremely improbable" as a means of compliance. Adds 1/1000 specific risk analysis on additional failure conditions. These changes will result in an increase in safety by requiring consideration of all jams, ensuring a minimum level of safety after the jam condition, and by clarifying the type of jam to be covered under (c)(3). Adds recognition of limitations in compliance achievable in the landing phase. This reduces the coverage in the rule, but it is an exclusion that has been allowed as a matter of practicality under the existing rule.
- 25.671(c)(4) Highlights requirement to address runaway. Requires addressing single failure regardless of probability. This change will result in an increase in safety by highlighting the need to address all single failures that could cause a runaway.
- 25.671(d) Clarifies all engine-out flight to be considered at any point in the flight. Requires flare capability. This change will improve the level of safety by clarifying that the capability must be provided throughout the flight regime and be sufficient for a flare to a landing.
- New-25.671(e) Adds requirement for recognition of control means at the limit of authority from recent fly by wire certifications. . This change will increase the level of safety by providing coverage absent in the current FAR/JAR.
- New-25.671(f) Adds requirement for mode annunciation from recent fly by wire certifications. . This change will increase the level of safety by providing coverage absent in the current FAR/JAR.

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9. **Relative to current industry practice, does the proposed standard increase, decrease, or maintains the same level of safety? [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]**

The proposed standard will increase the level of safety for the same reasons as described in #8.

10. **What other options have been considered and why were they not selected? [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.) Include the pros and cons associated with each alternative.]**

There was consideration to simply reference 25.1309 and its corresponding advisory material and use AC25-7A to address handling quality criteria with flight control failures. However, it was determined that material does not contain sufficient guidance to address jam failure conditions and accompanying demonstration. In addition, the intent of the material in the parentheses of 25.671(c)(2) is captured by the 1/1000 "specific risk" criteria that is not addressed in 25.1309. The Handling Quality Rating Method was not used because it is not harmonized with the JARs.

11. **Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]**

It is intended that this new rule material be applied in new certification programs. Manufacturers of transport category airplanes would be affected by the change. Operators using newly certified airplanes may be affected through additional non-normal procedures and operator training may be required to address jam failure conditions. Additional operator maintenance requirements may be driven by the 1 in 1000 residual safety requirement.

Note that this material introduces some extensive additions to the rule interpretation and new criteria. The full impact of such a change on the manufacturers cannot be predicted without application to an actual flight control certification program.

12. **To ensure harmonization, what current advisory material (e.g. ACJ, AMJ, AC, policy letters) need to be included in the rule text or preamble? ? [Does any existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]**

See enclosed rule and advisory material. A part of one JAR ACJ has been added to 25.671(a) because it was determined to be rule material.

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- 13. Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]**

There is no existing FAA advisory material for 25.671. See the enclosure 2 for proposed advisory material. Advisory Circular 25-7 does contain a method for assessing flight control failures that affect handling qualities that is acceptable to the FAA but not accepted by the JAA. Advisory Circular 25.672 relates to flight controls and is being addressed by the Loads & Dynamics Harmonization Working Group. See also the separate recommendation for 25.672.

- 14. How does the proposed standard affect the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]**

The proposed standard does not conflict with the current ICAO standard shown below. Compliance with 25.1309 using "Common Cause Analysis" provides coverage for the criteria in the ICAO standard.

ICAO change to Annex 8, effective March 12, 2000 :

"4.1.6(b) Aeroplane systems shall be designed, arranged and physically separated to maximize the potential for continued safe flight and landing after any event resulting in damage to the aeroplane structure or systems."

- 15. How does the proposed standard affect other HWG's? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]**

This proposed standard contains criteria and requires compliance for flight controls beyond that contained in 25.1309 and the Handling Qualities Rating Method in Appendix 7 of AC25-7A. In addition, since a primarily qualitative approach is used in the proposed 25.671 advisory material, there may be some inconsistencies with the numerical approach used in those two standards. It also must be compatible with the Structures standards developed for 25.302.

The FAA agrees that the 1/1000 criteria added to the rule text in 25.671(c)(2) is an acceptable replacement of the current "single plus probable" requirement, as described in #8 of this report. However, there is currently a review of alternative "specific risk" criteria under FAR/JAR 25.1309. The FAA believes that it is imperative that 25.1309 and 25.671 be fully compatible with regard to any specific risk criteria. Furthermore,

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the LDHWG has been requested to evaluate these specific risk criteria in regards to the possible implications to flutter prevention.

Another FAA concern relative to compatibility between guidance material is the interchangeable use of the term "dormant" in 25.671 and "latent" in 25.1309. The FAA believes it is important to use a common term to avoid confusion.

- 16. What is the cost impact of complying with the proposed standard? [Please provide information that will assist in estimating the change in cost (either positive or negative) of the proposed rule. For example, if new tests or designs are required, what is known with respect to the testing or engineering costs? If new equipment is required, what can be reported relative to purchase, installation, and maintenance costs? In contrast, if the proposed rule relieves industry of testing or other costs, please provide any known estimate of costs.]**

The new standard will increase the amount of evaluation for certification of flight controls, both in analysis and testing. Depending on the airplane architecture, system changes may be required in new certification programs for greater use of jam override devices or split control surfaces. Some duplicate analysis or testing may be avoided through FAR/JAR harmonization.

- 17. If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.**

See the Enclosure 3.

- 18. Does the HWG wish to answer any supplementary questions specific to this project? [If the HWG can think of customized questions or concerns relevant to this project, please present the questions and the HWG answers and comments here.]**

The working will be able to answer questions arising during the process of NPRM development. The HWG has no supplementary questions to provide.

- 19. Does the HWG want to review the draft NPRM at Phase 4 prior to publication in the Federal Register?**

Yes.

- 20. In light of information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the "Fast Track" process? [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]**

The HWG considers this project too complex for the "Fast Track" process.

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